

VENTURA RIVER, VENTURA COUNTY, CALIF.

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LETTER

FROM

THE SECRETARY OF WAR

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, UNITED STATES ARMY, DATED APRIL 25, 1941, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND AN ILLUSTRATION, ON A PRELIMINARY EXAMINATION AND SURVEY OF VENTURA RIVER, VENTURA COUNTY, CALIF., AUTHORIZED BY FLOOD CONTROL ACTS APPROVED JUNE 22, 1936, AND AUGUST 28, 1937

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JULY 23, 1941.—Referred to the Committee on Flood Control and ordered to be printed with an illustration

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WAR DEPARTMENT,  
*Washington, July 19, 1941.*

THE SPEAKER OF THE HOUSE OF REPRESENTATIVES.

DEAR MR. SPEAKER: I am transmitting herewith a report dated April 25, 1941, from the Chief of Engineers, United States Army, on preliminary examination and survey of Ventura River, Ventura County, Calif., authorized by the Flood Control Act approved August 28, 1937, and of Ventura Harbor, Calif., authorized by the Flood Control Act approved June 22, 1936, together with accompanying papers and illustration.

The Bureau of the Budget has been consulted and advises that, while there would be no objection to the submission of this proposed report, it would not be in accord with the program of the President, in the absence of evidence showing that the proposed works possess important defense values, to submit during the present emergency any estimate of appropriation for the construction of the project.

Sincerely yours,

HENRY L. STIMSON,  
*Secretary of War.*

WAR DEPARTMENT,  
OFFICE OF THE CHIEF OF ENGINEERS,  
*Washington, April 25, 1941.*

Subject: Ventura River, Ventura County, Calif.

To: The Secretary of War.

1. I submit for transmission to Congress my report with accompanying papers and illustration on preliminary examination and survey of Ventura River, Ventura County, Calif., authorized by the Flood Control Act approved August 28, 1937, and of Ventura Harbor, Calif., authorized by the Flood Control Act approved June 22, 1936.

2. Ventura River has its source in the Santa Ynez Mountains in southern California, flows south 32 miles and empties into the Pacific Ocean at Ventura, about 60 miles northwest of Los Angeles. The watershed has an area of 228 square miles, nearly half of which is mountainous with elevations up to 6,000 feet above sea level. Most of the remainder consists of foothills and only 14 percent of the area comprises valley land. The principal activity, production of petroleum products and natural gas, was estimated to have a value of \$17,400,000 in 1938. Some farming and manufacturing are also carried on. Ventura, with a population of 12,000, is the principal community.

3. Floods of sufficient magnitude to cause moderate damage have occurred on the average of once in 7 years since 1862. More severe floods, capable of causing extensive damage, have occurred about once in 15 years in the same period. In March 1938 direct losses of \$777,000 were suffered. The district engineer estimates that probable future flood damages, direct and indirect, will average \$217,600 annually. The area subject to overflow amounts to about one-third of the valley land in the basin and has a population of about three-fourths of the total basin population. Local interests have expended about \$100,000 on levee work which has been either temporary in character or inadequate for major floods. Check dams built by local interests at a cost of \$15,000 were destroyed by floods in 1933 and 1934. Local interests now desire channel improvements in the lower 15 miles of Ventura River, construction of debris basins and channel improvements in Ojai Valley, and construction of reservoirs for flood control and water conservation on Coyote, Matilija, and San Antonio Creeks.

4. The district engineer has investigated several possible flood-control plans, including those suggested by local interests. He finds that most of the flood losses have occurred in two sections, in and near the city of Ventura on the lower Ventura River, and in the city of Ojai below Stewart Canyon, and that flood control is not justified for other than these sections. He reports that reservoirs either for flood control alone or for flood control and water conservation, as desired by local interests, are impracticable due to excessive costs. He finds that the most economical plan of flood protection is one providing for a levee on the left bank of Ventura River to protect the city of Ventura and for a debris basin at the mouth of Stewart Canyon with a concrete channel to carry flood flows through the city of Ojai. The district engineer estimates that the levee work will cost \$1,084,000 for construction, \$6,000 for relocation of utilities and \$62,000 for rights-of-

way, a total of \$1,152,000. The annual charges, including \$5,300 for maintenance, are estimated to be \$55,000. Annual benefits would be \$73,300. The estimated cost of the debris basin and channel through Ojai is \$520,000 for construction, \$4,000 for relocation of utilities, \$27,000 for bridges or culverts, and \$36,000 for rights-of-way, a total of \$587,000. Annual charges, including \$6,700 for maintenance, would amount to \$32,300. This project would prevent direct and indirect flood losses of \$15,000 annually and would provide protection against disastrous loss of life. The district engineer considers both improvements warranted and recommends that the projects be constructed, subject to certain conditions of local cooperation. The division engineer concurs.

5. The Board of Engineers for Rivers and Harbors, concurring generally in the views of the district and division engineers, notes that the benefits of the proposed levee works are substantially in excess of the costs and is of the opinion that construction of the proposed debris basin and channel through Ojai is fully justified because of the protective value of the work against possible disastrous loss of life. The Board notes that local interests have furnished assurances that they will meet the required terms of local cooperation and recommends construction of the proposed improvements substantially as outlined in the report of the district engineer at an estimated first cost to the United States of \$1,600,000; subject to certain conditions of local cooperation.

6. After due consideration of these reports, I concur in the views of the Board. The improvements proposed by the district engineer constitute the most practicable flood-control plan for Ventura River and the projects are fully justified by the tangible benefits, the preservation of the economic welfare of the area, and the reduction of the hazard to human life. I recommend the construction of a levee on the left bank of lower Ventura River at Ventura, a debris basin in Stewart Canyon, and a concrete channel through the city of Ojai, substantially as outlined in the report of the district engineer, at an estimated first cost to the United States of \$1,600,000, subject to the provisions that responsible local agencies give assurances satisfactory to the Secretary of War that they will provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project; bear the expense of all necessary highway, bridge, and utility alterations; hold and save the United States free from claims for damages resulting from the construction of the works; and maintain all works after completion in accordance with regulations prescribed by the Secretary of War.

J. L. SCHLEY,  
*Major General,*  
*Chief of Engineers.*

## REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS

[Second endorsement]

BOARD OF ENGINEERS FOR RIVERS AND HARBORS,  
*Washington, D. C., March 31, 1941.*

To the CHIEF OF ENGINEERS, UNITED STATES ARMY.

The Board concurs in general in the views of the district and division engineers. Construction of a levee for the protection of Ventura is the most economical flood-control plan for that section of the valley, and the benefits are substantially in excess of the costs. Although the tangible benefits of the protective measures proposed for Ojai are less than the estimated costs, the Board is of the opinion that this portion of the project is justified when account is taken of the unevaluated benefits, including the economic welfare of the area and the reduction of hazard to human life. The Board recommends construction of a levee on lower Ventura River at Ventura, a debris basin in Stewart Canyon, and a channel through the city of Ojai, all at an estimated first cost to the United States of \$1,600,000; subject to the provisions that responsible local agencies give assurances satisfactory to the Secretary of War that they will provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project, bear the expense of all necessary highway, bridge, and utility alterations, hold and save the United States free from claims for damages resulting from the construction of the works, and maintain all the works after completion in accordance with regulations prescribed by the Secretary of War.

For the Board:

THOMAS M. ROBINS,  
*Brigadier General, Corps of Engineers,*  
*Senior Member.*

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## SURVEY OF VENTURA RIVER, VENTURA COUNTY, CALIF.

## SYLLABUS

The district engineer finds that there is a serious flood problem in and near the city of Ventura on lower Ventura River, and in the city of Ojai below Stewart Canyon. He concludes that construction of a left-bank levee on lower Ventura River is economically justified; and that construction of a debris basin at the mouth of Stewart Canyon and of a flood-control channel through the city of Ojai is warranted by the monetary savings to accrue from reduction of flood damage, by the increase in land value, and by the relatively large intangible benefits.

The district engineer recommends:

That a project be approved for construction of a levee on lower Ventura River, a debris basin at the mouth of Stewart Canyon, and a flood-control channel through the city of Ojai, all in the Ventura River Basin, at an estimated total Federal first cost of \$1,604,000 for construction, a total non-Federal first cost of \$135,000, and a non-Federal total annual maintenance cost of \$12,000.

That local interests be required to cooperate as follows: (1) Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of said flood-control works; (2) hold and save the United States free from all claims for damages arising from the construction and operation of the works; (3) assume the cost of the relocation of all public utilities required in the construction of the works; (4) assume the cost of the construction of all street and highway bridges required in connection with the improvements; and (5) maintain the completed works.

That the United States pay all other costs and perform all other work entailed in the construction of the proposed improvements.

That Federal funds sufficient to complete the improvements be made available in one allotment of \$1,604,000.

WAR DEPARTMENT,  
UNITED STATES ENGINEER OFFICE,  
*Los Angeles, Calif., October 15, 1940.*

Subject: Survey, flood control, Ventura River, Ventura County, Calif.

To: The Chief of Engineers, United States Army, Washington, D. C.  
(Through the Division Engineer, South Pacific Division, San Francisco, Calif.).

AUTHORITY

1. This report is submitted pursuant to act of Congress, Public No. 406, Seventy-fifth Congress, chapter 877, first session, H. R. 7646, approved August 28, 1937, which reads in part as follows:

\* \* \* \* \*

SEC. 5. That section 6 of the Act entitled "An Act authorizing the construction of certain public works on rivers and harbors for flood control, and for other purposes," approved June 22, 1936, is hereby amended by adding to the list of localities at which preliminary examinations and surveys are authorized to be made the following names: \* \* \* Ventura River, Ventura County, California.

The report is submitted also in compliance with the Flood Control Act approved June 22, 1936, which authorizes a preliminary examination and survey of Ventura Harbor, Calif. It is probable that Ventura Harbor inadvertently was specified instead of Ventura River. Section 6 of the Flood Control Act approved June 22, 1936, reads as follows:

The Secretary of War is hereby authorized and directed to cause preliminary examinations and surveys for flood control at the following-named localities, and the Secretary of Agriculture is authorized and directed to cause preliminary examinations and surveys for run-off and waterflow retardation and soil erosion prevention on the watersheds of such localities; the cost thereof to be paid from appropriations heretofore or hereafter made for such purposes: *Provided*, That no preliminary examination, survey, project, or estimate for new works other than those designated in this or some prior Act or joint resolution shall be made: *Provided further*, That after the regular or formal reports made as hereby authorized on any examination, survey, project, or work under way or proposed are submitted to Congress, no supplemental or additional report or estimate shall be made unless authorized by law or by resolution of the Committee on Flood Control of the House of Representatives or the Committee on Commerce of the Senate: *And provided further*, That the Government shall not be deemed to have entered upon any project for the improvement of any waterway mentioned in this Act until the project for the proposed work shall have been adopted by law: \* \* \*

Ventura Harbor, California.

2. A preliminary examination report, dated June 18, 1938, submitted in accordance with the provisions of the above acts, was reviewed by the Board of Engineers and a survey of Ventura River, Ventura County, Calif., was authorized by the Chief of Engineers September 30, 1938, to determine the advisability and cost of improvement and the local cooperation which should be required.

PRIOR REPORTS

3. There are no prior flood-control reports made by the Corps of Engineers, United States Army, concerning this drainage basin.

## DESCRIPTION

4. *Geographical description of drainage basin.*—The Ventura River Basin is in the coastal region of California, about 60 miles northwest of the city of Los Angeles and 300 miles southeast of San Francisco. It has an area of 228 square miles, of which 221 square miles are in Ventura County and the remainder in Santa Barbara County. The basin extends from the Pacific Ocean northerly about 21 miles, and its northern boundary is formed by the crest of one of the ranges of the Santa Ynez Mountains. The area is fan-shaped and in its northern part is about 19 miles wide.

5. *Topography and streams.*—The drainage area is generally rough and broken. Along the northern border there is a mountain range, varying from 4,000 to 5,000 feet in height. Mountains and foothills extend to the coast. Steep mountain slopes form the upper boarders of the drainage area in which the stream valleys are centrally located. Elevations range from 6,000 feet at Montecito Peak to sea level. About 100 square miles may be classified as mountainous, 96 square miles as foothill, and 32 square miles as valley area. (See pl. 1, enclosure 2.)<sup>1</sup>

6. Ventura River, formed by the junction of North Fork and Matilija Creek, is 16.5 miles long. Considering Matilija Creek as a continuation of the main stream, the total length is 32 miles and the total fall from source to mouth is 5,500 feet. The principal tributaries of Ventura River are North Fork, Matilija, San Antonio, and Coyote Creeks. In the mountainous part of the drainage basin the streams have steep gradients, the fall varying from 200 to more than 800 feet per mile. The average fall of the main stream below the junction of Matilija Creek and North Fork is about 54 per feet mile.

7. The drainage area of San Antonio Creek comprises approximately 40 square miles of steep, rough, mountainous territory and 12 square miles of valley land. The major part of the run-off comes from the mountains in the northern and eastern parts of the basin, flows over the debris cones at the base of the mountains, crosses the valley floor, and collects in San Antonio Creek, which follows a southwesterly course to Ventura River. The average fall of San Antonio Creek is 60 feet per mile and its length is 11.4 miles. Coyote Creek is the principal tributary in the west-central part of the basin and drains about 30 square miles of mountainous area and 11 square miles of foothill and valley lands. The average fall of Coyote Creek and its main branch is 260 and 380 feet per mile, respectively, and the extreme length of the watercourse is 16.6 miles.

8. The drainage area of Ventura River Basin is subdivided as follows:

*Drainage basin—Ventura River and tributaries*

Stream:	Drainage area (square miles)
Matilija Creek.....	56
North Fork.....	16
San Antonio Creek.....	52
Coyote Creek.....	41
Intermediate areas.....	63
Total.....	228

<sup>1</sup> Not printed.

9. *Geology and soils*.—Over the entire basin of Ventura River the exposed rock is of sedimentary origin, consisting mostly of sandstone, conglomerates, and shale. Approximately 85 percent of the area is composed of relatively impervious deposits. The formations are generally soft and easily eroded. The streams debouching from the mountainous areas have built up steep alluvial cones composed of large boulders and gravel near the mountains and grading off to silt and clay at the lower end of the basin. The mountains are steep and rugged and are composed of practically impervious materials.

10. Soil surveys of the Ventura area, California, were completed in 1920 by the United States Department of Agriculture. The residual soils, identified with the hilly and mountainous regions, form approximately 60 percent of the total soils of the area. Old valley fill and coastal-plain soils are most extensive at the lower elevations and along the narrow seacoast, while the recent alluvial or relatively permeable soils are more limited and prevail on most of the valley floors. A small amount of wind-laid soils is confined to a very narrow belt of drifting sand dunes along the ocean front.

11. *Stream characteristics*.—The steep gradients and fan-shaped lay-out of the basin produce high velocities in the streams and rapid concentration of floodwaters. Across the detrital cones at the foot of the steep mountain slopes the stream channels in many places are poorly defined and of inadequate capacity for flood flows. In these locations, changes in channel location are frequent. Within the flood plain of the Ventura River the main stream meanders widely, and the immense amount of debris carried by floods causes rapid and destructive shifts of the current. The stream channels generally are too ill-defined, limited in capacity, and unstable in character to give a definite indication of future flood stages.

12. *Climate*.—The climate of the Ventura River Basin is typical of that of the coastal region of southern California. In winter the temperature seldom falls below freezing except in the mountainous area, and the summer temperatures in the valley area seldom exceed 100°. At Ojai, 12 miles from the ocean and at elevation 900, the average monthly temperature varies from 51° in January to 73° in July. In comparison with the Ojai Valley the average monthly temperatures along the coast are about 5° warmer in winter and about 10° cooler in summer. In the interior, humidities are low except during storm periods. Persistent summer fogs prevail along the coast. Rainfall is seasonal and occurs during the winter and early spring.

13. *Vegetation*.—Most of the area is covered with chaparral and grassy woodland growths. Live oaks, sycamores, alders, cottonwoods, and willows are found along the stream beds, and conifers at higher altitudes. In some places the vegetal cover is very dense, but frequently large parts of the area are completely denuded by fires, such as those that occurred in 1917 and 1932. Cultivated lands constitute about 8 percent of the area of the basin.

14. *Maps*.—Published maps of the United States Geological Survey cover the entire drainage basin of Ventura River. Southern California sheet No. 3 of the United States Geological Survey edition of July 1910, scale 1 to 250,000, contour interval 250 feet, includes this drainage basin and adjacent territory. The Ventura and Santa Paula

quadrangles, scale 1 to 62,500 and contour interval 50 feet, cover the southern three-quarters of the basin and the Mount Pinos quadrangle, scale 1 to 125,000, contour interval 100 feet, covers the remainder. Soil maps are included in a report entitled "Soil Survey of the Ventura Area," by Bureau of Soils, United States Department of Agriculture. A general map of the Ventura River Basin is included as enclosure 1. This map shows the boundaries of the drainage area, the principal geographical features, limits of the overflow area, and locations of the improvements recommended. Other maps showing drainage areas, surface geology, location of rainfall and stream-gaging stations, and isohyets are included in enclosure 2.<sup>1</sup> Maps and plans of the recommended improvements are included with enclosure 4.<sup>1</sup>

#### ECONOMIC DEVELOPMENT

15. *Population.*—The present (1940) population of the drainage area is 9,000 to 10,000, of which about 55 percent is rural and 45 percent urban. The city of Ventura (official name, San Buenaventura) is on the coast, to the east of and adjacent to Ventura River. The population of the city (1940) is 12,422, of which about 3,000 reside in that part of the city which is in the Ventura River Basin. The only other incorporated area in the basin is the city of Ojai, which has a population estimated at 2,000. There are several unincorporated communities located in the valley areas of the main stream and its tributaries. The population in the overflow area of Ventura River is estimated at 4,750. In Ojai Valley, where the mountain streams have developed alluvial fans at the base of the mountains, the population of the extensive area that is menaced by floods has been estimated at 2,800.

16. The data given in the following table show the increase in population of the county of Ventura since 1890 and the city of Ventura since 1880.

#### *Population*

[From U. S. Census reports]

Year	Ventura County	City of Ventura
1880.....		1,370
1890.....	10,071	2,320
1900.....	14,367	2,470
1910.....	18,347	2,901
1920.....	28,724	4,156
1930.....	54,976	11,603
1940.....	68,883	12,422

The great increase in the population of the city of Ventura between 1920 and 1930 was due largely to the development of an oil field in the Ventura River Basin, about 2 miles north of the city.

17. *Production activities and resources.*—The principal activities of the Ventura River Basin are agriculture, the production of petroleum and natural gas, and manufacturing. The value of the total production in the basin during the year 1938 is estimated at \$18,600,000. The production of petroleum and natural gas is by far the most important. About 11,000 acres are devoted to the growing of citrus and deciduous

<sup>1</sup> Not printed.

fruits, nuts, and field crops, of which about 4,000 acres, including the most valuable crops, are irrigated. In the northern part of the basin about 64,000 acres, or 44 percent of the entire drainage area, are national forest lands which are utilized for recreation and a limited amount of grazing. The assessed valuation of all land and improvements in the Ventura River drainage basin, based on 50 percent of real value, is about \$25,000,000. The following table gives the estimated value of production in the basin during 1938.

*Value of production,<sup>1</sup> Ventura River Basin (1938)*

Petroleum products.....	\$13, 300, 000
Natural gas.....	4, 100, 000
Agriculture.....	700, 000
Manufacturing.....	500, 000
<b>Total.....</b>	<b>18, 600, 000</b>

<sup>1</sup> Estimated from reports of State and local agencies.

18. *Transportation facilities.*—The drainage basin of Ventura River is adequately served by the Southern Pacific Railroad, which crosses the river near its mouth and has a branch extending from Ventura up the valley to Ojai. The area is also served by United States Highway 101 and the Ventura-Maricopa Highway (United States Highway 399); the latter extends from Ventura north through the basin of Ventura River, thence in a northwesterly direction to the town of Maricopa in the San Joaquin Valley. There are also many county roads which serve the smaller valley and foothill areas.

#### PRECIPITATION

19. *Rainfall stations.*—The United States Weather Bureau has made observations at Ventura for a 50-year period, and in Ojai Valley for 33 years. The 46-year mean seasonal precipitation for the period 1892 to 1938 was computed for key stations, which are shown on an isohyetal map, plate 17, enclosure 2.<sup>1</sup> The mean seasonal precipitation varies from 16 inches near the coast to 38 to 40 inches in the mountainous area where the general elevation is from 4,500 to 5,500 feet above sea level. Precipitation data for three stations in the Ventura River Basin are given in the following table:

*Precipitation, Ventura River Basin, Calif.*

Station No. <sup>1</sup>	Station	Elevation	Period of record	Years of record	Maximum seasonal	Minimum seasonal	Average seasonal of record	Computed 40-year seasonal mean
		<i>Feet</i>	<i>Years</i>		<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>
107	Matilija Canyon <sup>2</sup> .....	950	{ 1902-11 1912-18 1919-38 }	34	50.75	9.49	26.36	24.57
30	Ojai <sup>3</sup> .....	900	1905-38	33	39.60	7.30	21.57	20.57
66	Ventura <sup>3</sup> .....	50	1873-1938	50	28.73	6.39	15.27	15.34

<sup>1</sup> For location of stations, see map, pl. 3, enclosure 2 (not printed).

<sup>2</sup> Record by local interests.

<sup>3</sup> U. S. Weather Bureau station.

<sup>1</sup> Not printed.

20. *Storms*.—An examination of recorded data on major storms in the Ventura River Basin indicates the following general characteristics: (1) The physiography of the basin is the primary factor controlling distribution of precipitation; (2) major storms are general over the entire basin; (3) excessive rainfall occurs without regard to cyclic trends of wet and dry periods; (4) the intensity and total volume of rainfall vary considerably throughout the basin; (5) the distribution of mean seasonal rainfall follows very closely that of observed storms, indicating that the same factors influence the rainfall of nearly all storms; (6) the principal factor controlling mean seasonal rainfall throughout the basin is the variation of rainfall intensity rather than storm duration; (7) major storms, in general, have a duration of 4 days and the maximum day may occur near the end of the storm; (8) there is a diurnal variation of intensities reaching a maximum, on the average, at the expiration of 18 hours of the rainfall day; (9) storm transposition is not applicable to Pacific-coast basins, such as the Ventura River Basin, where the orographic effect is the principal factor controlling the distribution of rainfall intensity.

21. *General features*.—A statistical analysis of the recorded rainfall at 26 stations in and near the basin and other hydrological investigations were made and are incorporated in enclosure 2,<sup>1</sup> Hydrology, Ventura River Basin, Calif.

#### RUN-OFF

22. *Stream gaging stations*.—Stream gaging stations in the Ventura River Basin have been operated for short periods only and the records are fragmentary. Because of the limited run-off data and the wide variation in seasonal precipitation, the mean seasonal run-off has been estimated for a long period of years in order to include the cyclic extremes. On the basis of a 46-year period, 1892-93 to 1937-38, inclusive, the mean annual run-off of Ventura River below Coyote Creek is estimated at 52,600 acre-feet. Minimum seasonal run-off and maximum seasonal run-off during this same period are estimated at 100 acre-feet and 157,000 acre-feet, respectively.

23. *Available data and studies*.—A detailed hydrological study has been made of the entire basin and is included in enclosure 2.<sup>1</sup> The results of this study are summarized in the following table:

*Design flood data, Ventura River Basin*

Dam site or other concentration point	Drainage area	Peak flow		Rainfall maximum, 24 hours	Run-off maximum, 24 hours
		Total	Per square mile		
	Square mile	Cubic feet per second	Cubic feet per second	Inches	Acre-feet
Ventura River:					
At mouth.....	228.0	150,000	658	10.35	74,600
Foster Park Dam site.....	190.0	145,000	763	10.80	66,100
Above Coyote Creek.....	149.0	121,000	812	11.24	55,100
Above San Antonio Creek.....	95.0	89,000	937	12.00	40,500
Matilija Dam site.....	72.0	90,000	1,250	13.25	33,800
Tributaries:					
Hoffman Dam site.....	35.9	30,000	836	9.42	10,300
San Antonio Dam site.....	47.5	41,000	863	9.72	14,200
Stewart Canyon.....	1.9	5,700	3,000	10.6	-----
Senor and Gridley Canyons.....	10.0	22,000	2,200	10.9	-----
Senor Canyon.....	5.7	15,000	2,630	11.5	-----
Gridley Canyon.....	3.9	9,400	2,410	11.5	-----
Horn Canyon.....	4.0	10,500	2,630	11.9	-----

<sup>1</sup> Not printed.

## FLOODS

24. *Flood records.*—The stream gaging stations maintained by the United States Geological Survey and local agencies have been operated for such short periods that but little information concerning floods in the Ventura River Basin is available from this source. Unpublished data obtained from the United States Geological Survey indicate that the estimated flood crests in the Ventura River Basin during the storm of February 27 to March 3, 1938, were about as follows:

*Estimated flood crest, Ventura River Basin, Mar. 2, 1938*

Stream	Location of gaging station		Station No. <sup>1</sup>	Drainage area	Crest of flood
	At or near—	River mile—			
Matilija Creek.....	Matilija.....	16.9	1	<i>Square mile</i> 55.0	<i>Cubic feet per second</i> 15,200
Coyote Creek.....	Ventura.....	.5	6	41.1	11,500
Ventura River.....	do.....	6.2	3	187.0	39,200

<sup>1</sup> Location of station shown on map, pl. 3, enclosure 2 (not printed).

25. The recorded flood data are of limited value in determining the magnitude and frequency of floods in this basin. Therefore, a search was made for historical data showing the frequency of floods for a long period of years.

26. Historical data and recent records show that during the 77-year period, 1862 to 1938, inclusive, floods of sufficient magnitude to cause extensive damage throughout the Ventura River Basin occurred as follows: 1862, 1867, 1884, 1911, 1914, and 1938, or with a frequency of about one in 15 years. Floods of lesser magnitude, but large enough to cause damage in the more exposed areas, occurred in 1875, 1889, 1905, 1907, 1910, 1915, 1916, 1926, 1927, 1934, and 1937, or with a frequency of about one in 7 years. In addition to the large floods, many small floods have occurred which caused damage in the lower exposed areas in the basin. The flood of 1862 was probably the greatest of all. A description of the large floods referred to above is given in enclosure 3.<sup>1</sup>

27. *Flood frequencies.*—From the historical data and records, estimates were made showing the probable frequency of floods on Ventura River as follows:

*Flood frequencies, Ventura River (100-year period)*

Character of flood:	Number of floods
Flood which may approach a probable maximum, causing great property damage and considerable loss of life (approximating 140,000 cubic feet per second).....	1
Floods from general storms, causing extensive damage throughout the basin (45,000 to 100,000 cubic feet per second).....	7
Floods of sufficient magnitude to cause damage in the more exposed areas (20,000 to 45,000 cubic feet per second).....	14
Small floods, usually local, that cause damage in widely scattered areas of the basin (under 20,000 cubic feet per second).....	20

<sup>1</sup> Not printed.

The data concerning flood frequencies form the basis for estimates of damage from future floods. (See enclosure 3.<sup>1</sup>)

28. *Flood characteristics.*—Floods of the Ventura River Basin are typical of those on the majority of streams in southern California. The major storms produce rainfall of high intensity and short duration. The combined effect of the general physiographical condition of well-entrenched streams having steep gradients, the impervious nature of most of the formations, the general fan-shape arrangement of the tributary areas, and the distribution of rainfall causes a high rate of run-off which quickly concentrates in the main channel and occasionally results in violent and destructive floods. The streams attain their peak flow within a few hours and subside with similar rapidity. The rapid rise of peak flows, high destructive velocities, and erratic behavior of debris-laden currents allow little time for emergency measures of protection or even flood warnings. However, during a large part of the year, the river carries little water; approximately 75 percent of the run-off occurs from January to April, inclusive. Run-off originating on precipitous mountain slopes flows through the canyons at high velocities, carrying large quantities of debris. The floodwaters from the mountains, upon reaching the gentler slopes of the alluvial areas, are reduced in velocity, causing the detrital material to be deposited. The boulders and coarser gravels are deposited near the mouths of the canyons and the sand and finer materials are carried farther downstream. This movement of detritus is another important element in the destructive action of the floods.

#### EXTENT AND CHARACTER OF FLOODED AREA

29. The overflow area of Ventura River is well-defined and includes nearly all the valley floor between the mesas and low hills on each side. In the Ojai Valley the overflow areas of the streams are not well-defined. Individual floods overflow different areas, and over a long period of years the damaged area may extend over most of the valley. Data concerning the area subject to overflow, and other pertinent data, are given in the following table:

*Overflow area, Ventura River Basin*

Basin subdivision	Area subject to overflow	Percent of total area	Population in overflow area	Estimated true value of property in overflow area
	<i>Acres</i>			
1. Ventura River below Coyote Creek .....	2, 100	29	4, 250	\$6, 225, 000
2. Ventura River below Ventura Ave. oil field (included in item 1) .....	(1, 500)	(21)	(3, 950)	(4, 500, 000)
3. Overflow area lying on east side of Ventura River below Ventura Ave. oil field (included in items 1 and 2) .....	(1, 000)	(14)	(3, 925)	(4, 250, 000)
4. Ventura River above Coyote Creek and below Matilija Creek .....	2, 000	28	500	380, 000
5. Stewart Canyon (in Ojai) .....	310	4	1, 700	900, 000
6. Horn Canyon, Senor Canyon, and San Antonio Creek .....	2, 500	35	1, 100	2, 000, 000
7. Coyote Creek (below dam sites) .....	250	4	50	75, 000
Total .....	7, 160	100	7, 600	9, 580, 000

<sup>1</sup> Not printed.

## FLOOD DAMAGE

30. *Damage from past floods.*—Only meager data are available showing the damages from past floods in this drainage basin. A tabulation of damage from floods during the period 1832–1937, inclusive, based on information furnished by local interests, is given in enclosure 3. Concerning many of the flood occurrences, mention is made of the kind of damage caused without giving a monetary evaluation of the damage. The flood years for which estimates of damage were made are given in the following table:

<i>Damage from past floods, Ventura River Basin (based on data submitted by local interests)</i>		<i>Estimated damage</i>
Year of flood:		
1884.....		\$50,000
1911.....		43,488
1914.....		237,601
1927.....		2,281
1934.....		85,500
Total.....		418,870

31. This partial estimate of the flood damage does not give an adequate estimate of possible future flood losses, not only because of incompleteness of record but also on account of the increase in the value of the improvements within the overflow area in recent years. The damage caused by the flood of 1938 provides a better basis for estimating possible future flood losses.

32. The damage caused by the flood of March 2, 1938, was determined by this office by an extensive field investigation made during and immediately following the flood. The results thereof are given in the following table:

*Flood-damage survey, Ventura River Basin, storm of Feb. 27–Mar. 3, 1938*

	<i>Direct damage</i>
Residential property.....	\$54,015
Business property.....	72,340
Industrial property.....	162,807
Agricultural property.....	169,075
Highways and roads.....	268,395
Highway bridges.....	4,141
Railroads and bridges.....	2,758
Water systems.....	1,800
Sewer systems.....	9,500
Gas systems.....	1,467
Electric systems.....	3,382
Telephone systems.....	14,303
Telegraph systems.....	800
Miscellaneous.....	12,000

Total direct physical damage..... 776,783

33. *Damage from future floods.*—The flood of March 2, 1938, on the Ventura River is the only one covered by a flood-damage survey furnishing sufficient information for use in estimating future flood damage. Based upon the data concerning this flood and supplemental data, the damage from a flood approaching the magnitude of a probable maximum flood, and the damage from floods of lesser magnitude, have been estimated in the areas subject to such damage. (See enclosure

3.<sup>1)</sup> Following the 1938 flood a flood-damage survey also was made in the Los Angeles area, which furnished data relative to both direct and indirect flood damage. Estimates have been made of indirect damage from these data and from a review of the allowance for indirect damage used by other agencies for areas having similar characteristics and development. The indirect damages are, in general, applicable to the community as a whole rather than to individual areas damaged, and have not been established as separate ratios for various property classifications. In the Los Angeles and San Gabriel Rivers and their tributaries, and Ballona Creek, Calif., survey report, dated February 5, 1940, an average value of 0.6 was used for all areas as the ratio of indirect to direct damage. Flood losses in the Ventura River Basin are similar in many respects to such losses in the Los Angeles area. This area, however, is one of small communities; its organization is less complex than that of the Los Angeles metropolitan area; and other features indicate that its indirect losses are appreciably lower. Consequently, a ratio of 0.3 has been used in this report. The resultant estimates of the average annual damage from future floods are given in the following table:

*Estimated average annual damage from future floods, Ventura River Basin (including the damage in only those parts of the basin below upper limits of improvements considered)*

Item	Locality	Damages		
		Direct	Indirect	Total
1	Ventura River below Coyote Creek.....	\$97, 100	\$29, 100	\$126, 200
2	Ventura River below Ventura Ave. oil field (included in item 1).....	(65, 100)	(19, 500)	(84, 600)
3	Overflow area lying on east side of Ventura River below Ventura Ave. oil field (included in items 1 and 2).....	(54, 200)	(16, 300)	(70, 500)
4	Ventura River above Coyote Creek and below Matillija Creek.....	28, 800	8, 600	37, 400
5	Stewart Canyon (in Ojai).....	11, 500	3, 500	15, 000
6	Horn Canyon, Señor Canyon, and San Antonio Creek.....	27, 600	8, 300	35, 900
7	Coyote Creek (below dam sites).....	2, 400	700	3, 100
	Total, Ventura River Basin.....	167, 400	50, 200	217, 600

#### EXISTING FLOOD CONTROL PROJECTS

34. There is no existing project in the drainage basis of Ventura River over which the War Department has jurisdiction.

#### IMPROVEMENTS BY OTHER FEDERAL AND NONFEDERAL AGENCIES

35. No flood-control works have been constructed within this area by any other Federal agency. Local interests, however, have done a small amount of flood-control work. A rock-protected levee has been constructed on the left bank of Ventura River, extending upstream from the Southern Pacific Railroad bridge, river mile 0.2, to a point a short distance above United States Highway 101, river mile 0.6. A small amount of levee work also has been done on the left bank of the river near the La Cross Bridge. Channel excavation and clearing have been done at various places on the main stream and its tributaries. Since 1911 at least \$100,000 has been spent on such work, most of which is either temporary in character or inadequate to

<sup>1</sup> Not printed.

withstand the ravages of major floods. Check dams built in Horn Canyon in 1929-30, at a cost of \$15,000, were nearly all destroyed by the floods of 1933 and 1934.

#### IMPROVEMENTS DESIRED

36. A public hearing was held at Ventura, Calif., October 19, 1937, which was attended by about 90 persons, including local, city, and county officials, representatives of the State, the United States Department of Agriculture, and various civic organizations, as well as the general public. The hearing disclosed, in general, that local interests desire:

(a) Improvement for flood control of the channel of Ventura River from the ocean to a point 15.4 miles upstream, which is near the base of the mountains.

(b) The construction of a dam on Coyote Creek, with a view to flood control and water conservation combined.

(c) The construction of dams on Matilija and San Antonio Creeks, with a view to flood control and water conservation combined.

(d) The construction of debris basins and channel improvement on the tributaries of San Antonio Creek for the protection of the city of Ojai and the citrus groves in Ojai Valley.

(e) Protection of the brush cover in the drainage basin and maximum practicable conservation of water incidental to flood control.

37. Although in favor of flood control, some local groups oppose the construction of storage dams in the basin of Ventura River, the objections being based on the contention that there are no sites suitable for the construction of safe dams.

38. The improvements desired by the city of Ventura are included in a plan for an additional municipal water supply which provides for a dam and storage reservoir at the Hoffman site on Coyote Creek, including provision for augmenting the water supply from Coyote Creek by diverting floodwaters into the storage basin from Ventura River. The cost of this improvement was estimated by local interests at \$1,638,424. In connection with the local studies resulting in the development of this plan, storage sites on Matilija and San Antonio Creeks were considered and found infeasible. In addition to the above improvements, the city of Ventura also desires that consideration be given to channel improvement of Ventura River, extending 15.4 miles upstream from the ocean, at a cost estimated by local interests at \$1,950,000.

39. The plan proposed by local interests for protection of the highly developed areas in Ojai Valley, which are in the upper basin of San Antonio Creek, consists in general of three debris basins and channel improvement. No estimate of cost of this work was submitted by local interests.

40. During the progress of this flood control survey, the city of Ventura, by resolution of its city council, manifested its desire to cooperate in any satisfactory plan providing for flood control and water conservation by the construction of a dam at the Foster Park site on Ventura River. (See resolution No. 1560, enclosure 6.)<sup>1</sup>

<sup>1</sup> Not printed.

## FIELD SURVEYS

41. Aerial surveys covered the valleys of Ventura River and its tributaries. Instrumental surveys were made of the river channel from the ocean to Foster Park, a distance of about 7 miles, with cross sections taken at 500-foot intervals. Additional channel surveys, amounting to 13 miles, were made in Ojai Valley, covering drainage channels below Stewart, Senor, Gridley, and Horn Canyons, and topographical surveys covered the locations of debris basins in these canyons. Dam sites on the river at Foster Park and on San Antonio Creek near Lion Canyon were surveyed to a limited extent for the purpose of preliminary estimates, and a detailed investigation, including drilling, was made at the Foster Park Dam site. General field inspections extended throughout the drainage basin, with representatives of local interests participating. The economic investigations included a review of data in the offices of the county and city of Ventura relating to values, damages, and benefits. The district engineer has examined the dam sites and channels, and has investigated the flood problems in the Ventura River Basin.

## FLOOD PROBLEMS

42. Initial consideration of the flood problems of the Ventura River Basin led to the division of the overflow area into five parts since flood control in each part had distinctive features. It is obvious that at present there is insufficient economic justification for the protection of lands along Coyote Creek or along that part of Ventura River above Coyote Creek and below Matilija Creek. Within Ojai Valley the lack of satisfactory reservoir sites in the steep narrow canyons prohibits flood control by means of storage basins, and to control the heavy debris load carried by the streams requires the construction of debris basins in connection with channel work. A reservoir on Matilija Creek, although it would afford protection to the upper Ventura River Valley, would not give adequate control of the river below its two main tributaries, San Antonio Creek and Coyote Creek. Conservation of water is important, and a reservoir on the main stream just below Coyote Creek, at Foster Park, would provide partial flood control of the lower river and adequate water conservation for the city of Ventura and the adjacent area along the river. An analysis of the problem in this area led to the study of various plans involving storage, channels, and levees.

## PLAN OF IMPROVEMENT

43. *Recommended plan.*—The plan recommended for flood control in the Ventura River Basin consists of a levee on the left bank of lower Ventura River to protect the city of Ventura, and channel improvement, including a debris basin in Stewart Canyon, to protect the city of Ojai. A brief description of this plan follows.

(a) *Lower Ventura River.*—The plan recommended for protection of the city of Ventura consists of a levee on the left bank extending from the ocean, river mile 0, to a point on the southerly bank of Canada de San Joaquin, river mile 2.6, where the levee would cross the railroad. From this point the levee would follow the left bank of Canada de

San Joaquin until the crown of the levee meets existing ground level. The levee would be a compacted earth fill with a 2-on-1 back slope and a 1½-on-1 river slope. The width of crown would vary from 18 feet to 24 feet. The levee is designed to protect the city from a flood of the magnitude of 150,000 cubic feet per second, with computed velocities varying from 8 to 17 feet per second. In the upper reaches of the levee a freeboard of 3 feet is provided, and in the lower reaches the freeboard is 5 feet. A blanket of dumped derrick stone would protect the levee from scour. The location and a typical cross section of the levee are shown on enclosure 1. For further details concerning the proposed levee, see enclosure 4.<sup>1</sup>

(b) *Stewart Canyon, Ojai.*—In Ojai Valley the recommended plan for flood control consists of a debris basin at the mouth of Stewart Canyon and a rectangular concrete channel from the debris basin extending through the city of Ojai to a natural channel south of the railroad. The designed capacity of the debris basin is 200,000 cubic yards. The debris dam, including spillway, is 610 feet long and its crest is at elevation 917. An ogee spillway 80 feet long and 13 feet high is provided and its crest elevation is 900. The proposed channel from the debris basin is 4,458 feet long and is designed for a maximum discharge varying from 5,700 cubic feet per second in the upper part of the channel to 6,700 cubic feet per second in the lower part, with a freeboard of approximately 2 feet. The channel width varies from 14 to 18 feet, and the wall heights from 10 to 11 feet. The location and typical sections of the proposed Stewart Canyon Channel are shown on enclosure 1. For details concerning the design of Stewart Canyon Channel and debris basin, see enclosure 4.<sup>1</sup>

44. The detailed cost estimates given in enclosure 5 are summarized in the following table:

*Estimated cost of recommended plan, Ventura River Basin*

Flood control on lower Ventura River:	
Levee, including channel clearing-----	\$1,064,000
Southern Pacific R. R., Ojai branch, bridge and levee gate-----	20,000
Relocation of utilities-----	6,000
Total construction cost-----	1,090,000
Rights-of-way-----	62,000
Total first cost, flood control on lower Ventura River-----	1,152,000
Flood control, Stewart Canyon in the city of Ojai:	
Debris basin-----	291,000
Concrete channel-----	219,000
Southern Pacific R. R., Ojai branch, bridge-----	10,000
Highway and street bridges-----	27,000
Relocation of utilities-----	4,000
Total construction cost-----	551,000
Rights-of-way-----	36,000
Total first cost, flood control, Stewart Canyon in the city of Ojai-----	587,000

45. *Alternative plans.*—In connection with the investigation and study of the flood-control problem, consideration was given to proposals by local interests for storage reservoirs, debris basins, and

<sup>1</sup> Not printed.

channel improvement. Local interests especially desire that full consideration be given to their proposal for a multiple-purpose project combining flood control with water conservation. Of the four dam sites suggested by local interests, three are located on tributaries and one on the main stream of Ventura River. The three sites located on tributaries of Ventura River are the Matilija on Matilija Creek just upstream from its junction with the north fork of Ventura River, San Antonio on that creek 4.4 miles above its mouth, and the Hoffman site on Coyote Creek 4.1 miles above its mouth. An investigation indicated that reservoirs at the three sites named would not provide adequate flood control on lower Ventura River. The cost of the three dams, plus the cost of required channel improvement on the lower river, showed clearly that flood control by this means could not be justified.

46. Preliminary studies indicated that use of the Foster Park Dam and Reservoir site located on Ventura River, at river mile 6, below all important tributaries, might be warranted as a multiple-purpose project for flood control and water conservation combined. Therefore, a detailed investigation was made of this dam site. It was found that the foundation and abutments are poor and that a dam at this site would be costly. It was also found that although the crest flow of great floods could be materially reduced, the reduced flow, plus the unregulated inflow below the dam, would exceed the safe carrying capacity of the river channel, thus channel improvement on the lower river would also be required.

47. In addition to the recommended plan providing for one levee, six additional plans for flood control on lower Ventura River were considered. The first three, plans A, B, and C, provide for some water conservation. The costs and economic ratios of the alternative plans are given in paragraph 51, and the principal features thereof are as follows:

Plan A: A dam at the Foster Park site, with a total storage capacity below spillway crest of 34,500 acre-feet, to reduce the design flood of 145,000 cubic feet per second to 29,000 cubic feet per second and for an improved channel from the junction of Canada de San Joaquin to the ocean, designed for a controlled flow of 45,000 cubic feet per second.

Plan B: A dam at the Foster Park site, the same as in plan A, and for a limited amount of levee work to protect the city of Ventura and adjacent area from a controlled flow of 45,000 cubic feet per second.

Plan C: A dam at the Foster Park site as in plan A, and for an improved channel from the dam outlet stilling basin to the ocean, designed for a controlled flow varying from 31,000 cubic feet per second in the upper part of the channel to 45,000 cubic feet per second in the lower part.

Plan D: A concrete trapezoidal channel extending from Canada de San Joaquin (river mile 2.6) to the ocean and designed for an uncontrolled flow of 150,000 cubic feet per second.

Plan E: Plan E omits the dam and provides a concrete trapezoidal channel (except a small part, which is rectangular) extending from the Foster Park Dam site (river mile 6) to the ocean. The channel is designed for an uncontrolled flow varying from 145,000 cubic feet per second in the upper part of the channel to 150,000 cubic feet per second in the lower part.

Plan F: A levee on the left bank of the river from the junction of the Canada de San Joaquin (river mile 2.6) to the ocean, the excavation of the existing channel in the lower reaches, and the construction of a concrete-pile trestle to replace the existing fill between the Southern Pacific Railroad bridges near the ocean. The improvement under this plan would provide protection from an uncontrolled flow of 150,000 cubic feet per second.

48. Within Ojai Valley, a satisfactory plan of improvement requires debris basins at the canyon mouths to catch the debris, and concrete-lined channels to carry the water from the basin outlets through the areas susceptible to flood damage. The flooded area is divided into two units, one embracing most of the agricultural area lying directly east of the city of Ojai and the other lying wholly within the city. In the first area, provision of debris basins at Gridley, Senor, and Horn Canyons, and concrete channels from the debris basins to the junction of Horn Canyon and San Antonio Creek channels is estimated to cost \$5,903,000, with annual charges amounting to \$316,800.

49. The relatively high flood discharges from these canyons carry a heavy debris load which fills the channels on the valley floor and makes them unstable in location and inadequate in capacity to carry the full volume of flood discharge. The debris cones at the mouths of the canyons are very steep, and the stream channels have maximum gradients of over 10 percent. To withstand the resulting velocities, ranging from 40 to 80 feet per second or more, would require concrete channel construction which would be costly. Benefits from flood control in this agricultural area are insufficient to justify the expensive construction necessary to establish permanent control. Also, annual maintenance would be costly, since debris basins must be cleaned out regularly to insure their full capacity being available in time of flood.

50. The overflow area within the city of Ojai is menaced by floods from Stewart Canyon. Flood control can best be provided by a debris basin at the mouth of Stewart Canyon and a rectangular concrete-lined channel extending from the debris basin to just below the Southern Pacific Railroad. Two locations for the channel were investigated, one lying in or near the depression just west of Canada Street, and the other between Canada and Blanche Streets. The latter location is preferable because of better channel alinement, shorter length of channel required, and less costly right-of-way.

51. *Summary of costs.*—A summary of the estimated costs and economic ratios of the foregoing plans follows:

	Construction cost	Total first cost, including right-of-way	Annual charges	Economic ratio <sup>1</sup>
Lower Ventura River:				
Plan A.....	\$11,452,000	\$11,724,000	\$586,200	0.34
Plan B.....	8,408,000	8,658,000	440,600	.43
Plan C.....	15,915,000	16,240,000	762,500	.27
Plan D.....	4,462,000	4,492,000	202,900	.46
Plan E.....	15,355,000	15,435,000	693,600	.19
Plan F.....	1,541,000	1,621,000	76,200	1.15
Recommended plan.....	1,090,000	1,152,000	55,000	1.33
Ojai Valley:				
East of Ojai.....	5,858,000	5,903,000	316,800	.15
Recommended plan within Ojai.....	551,000	587,000	32,300	.49

<sup>1</sup> Based on tangible benefits alone.

## ESTIMATES OF FIRST COST AND ANNUAL CHARGES—RECOMMENDED PLAN

52. The economic cost of the improvements included in the recommended plan is as follows:

## LOWER VENTURA RIVER

(a) Federal investment:	
(1) Estimated expenditure by the Engineer Department:	
Levee protection below the Ventura Ave. oil field..	\$1, 064, 000
Southern Pacific R. R., Ojai branch, bridge and levee gate.....	20, 000
(2) Total Federal first cost and total Federal investment.....	1, 084, 000
(b) Federal annual charges:	
(1) Interest, 3.5 percent on item (a) (2).....	37, 900
(2) Amortization of Federal investment, in 50 years at 3.5 percent, 0.00763 by item (a) (2).....	8, 300
(3) Federal annual charges.....	46, 200
(c) Non-Federal investment:	
(1) Estimated expenditure by local interests:	
Utilities.....	6, 000
Rights-of-way.....	62, 000
(2) Total non-Federal first cost and total non-Federal investment.....	68, 000
(d) Non-Federal annual charges:	
(1) Interest, 4.5 percent on item (c) (2).....	3, 100
(2) Amortization of non-Federal investment, in 50 years at 4.5 percent, 0.00560 by item (c) (2).....	400
(3) Cost of maintenance and operation, levee and channel..	5, 300
(4) Non-Federal annual charges.....	8, 800
(e) Total annual charges:	
(1) Federal annual charges.....	46, 200
(2) Non-Federal annual charges.....	8, 800
(3) Total annual charges.....	55, 000

## STEWART CANYON, OJAI

(a) Federal investment:	
(1) Estimated expenditure by the Engineer Department:	
Debris basin.....	\$291, 000
Concrete channel.....	219, 000
Southern Pacific R. R., Ojai branch, bridge or culvert (replaced by closed conduit).....	10, 000
(2) Total Federal first cost and total Federal investment.....	520, 000
(b) Federal annual charges:	
(1) Interest, 3.5 percent on item (a) (2).....	18, 200
(2) Amortization of Federal investment, in 50 years at 3.5 percent, 0.00763 by item (a) (2).....	4, 000
(3) Federal annual charges.....	22, 200

ESTIMATES OF FIRST COST AND ANNUAL CHARGES—RECOMMENDED  
PLAN—continued

STEWART CANYON, OJAI—continued

(c) Non-Federal investment:	
(1) Estimated expenditure by local interests:	
Utilities-----	\$4, 000
Highways and street bridges or culverts-----	27, 000
Rights-of-way-----	36, 000
(2) Total non-Federal first cost and total non-Federal investment-----	67, 000
(d) Non-Federal annual charges:	
(1) Interest, 4.5 percent on item (c) (2)-----	3, 000
(2) Amortization of non-Federal investment, in 50 years at 4.5 percent, 0.00560 by item (c) (2)-----	400
(3) (a) Cost of maintenance and operation of structures, 0.5 percent of item (a) (1), debris basin and concrete channel only, and item (c) (1) structures-----	2, 700
(b) Cost of removal of debris from debris basin, 10,000 cubic yards per annum at \$0.40 per cubic yard-----	4, 000
(4) Non-Federal annual charges-----	10, 100
(e) Total annual charges:	
(1) Federal annual charges-----	22, 200
(2) Non-Federal annual charges-----	10, 100
(3) Total annual charges-----	32, 300

ESTIMATES OF AVERAGE ANNUAL BENEFITS

53. *General discussion of benefits.*—Tangible benefits are susceptible of definite evaluation and consist principally of direct flood damage prevented, indirect losses prevented, and increase in value of lands resulting from flood control. For the purpose of determining the economic justification, benefits are reduced to an average annual basis for comparison with the average annual cost of the improvement.

54. *Average annual direct and indirect flood damages prevented.*—The basis of computations of direct and indirect damages from future floods is given in paragraph 33, and details thereof in enclosure. 3<sup>1</sup> The estimated average annual preventable damages on the lower Ventura River amount to \$54,200 direct and \$16,300 indirect; and in the city of Ojai, \$11,500 direct and \$3,500 indirect.

55. *Increased land values resulting from flood control.*—Within the areas protected from floods there are lands that will increase in value, due to a change to a higher use made possible by flood control. These benefits have been evaluated by considering the increase in value to be gradual and accruing over a period of years, and that the annual increment in value is constant. The annual benefit is assumed to be a perpetual return on the present worth of an annuity at compound interest for the period of development. The amount of the annuity is taken as the increase in land value divided by the number of years in the development period. The detailed method of determination is given in enclosure 3.<sup>1</sup> The estimated annual benefits from increased

<sup>1</sup> Not printed.

land values on the lower Ventura River are \$2,800 and in the city of Ojai, \$800.

56. *Intangible benefits.*—These benefits cannot be evaluated and are not included in the values used in computing the ratios of economic justification of the improvements given in table, paragraph 51. Along the lower Ventura River and in the city of Ojai, adequate flood control will provide large benefits of this character. Within and adjacent to the city of Ventura, in the overflow area of lower Ventura River, there are about 3,900 people, and the homes of at least a third of them are seriously menaced by floods. The steep gradient of the stream and its torrential character give little opportunity for warning of approaching floods. If the crest of a major flood arrived suddenly at night, many people doubtless would be drowned before the area could be evacuated.

57. In the city of Ojai the greater part of the residential and business property is on a debris cone at the mouth of Stewart Canyon. Topographical and hydrological conditions affecting this area are such as to indicate the probability of occurrence here of a disaster similar to the flood and debris flow of January 1934 in Montrose and La Crescenta, Calif., which caused the loss of more than 40 lives. In Ojai, floods probably would disrupt the local water supplies and seriously damage the sewage-disposal plant located on the bank of the existing main channel, thus increasing the possibility of epidemics. Floods affecting a large part of the city and suburban population would materially affect the city as a whole, and major disasters in this area would permanently retard normal growth. Since Ojai is the only community locally serving the Ojai Valley, a disaster to that city would have a widespread effect on the normal life and growth of the entire Ojai Valley.

58. In view of the foregoing, it is believed that on the basis of the intangible benefits alone the flood control improvements recommended for protection of the cities of Ventura and Ojai are well justified. It is not feasible to evacuate the areas subject to the flood menace.

59. *Collateral benefits.*—Consideration has been given water conservation and the development of hydroelectric power incident to flood control. These data are presented in the following paragraphs.

60. *Water power.*—In southern California the dry season generally extends over 6 months and dry periods lasting for several years are not uncommon. Although small water-power plants are operating successfully in the mountainous areas of southern California, it is believed that the development of water power incidental to flood control is impracticable in the Ventura River Basin.

61. *Water supply and water conservation.*—The average annual discharge of the Ventura River below Coyote Creek is estimated at 52,600 acre-feet (par. 22). Approximately 90 percent of this water wastes into the ocean during winter floods, and adequate supplies to meet all water requirements of the lower valley and the city of Ventura depend upon provision being made for storage.

62. For some time the city of Ventura has been in need of a more dependable water supply. The Ventura Avenue oil field and rural and suburban territory along the river north of the city, and the city itself, are served by the city's system, principally from the supply diverted from Ventura River at Casitas Narrows. During several

years, demands have exceeded the supply from Ventura River. From the city's investigations it appears that the Ventura River and its tributaries are a more satisfactory source of supply than wells on the coastal plain. Efforts have been made to provide storage on Coyote Creek, but the proposed bond issues for this purpose have been defeated at the polls. The city of Ventura, through a resolution adopted by its city council, dated February 26, 1940, endorsed plans and a program for flood control by means of a reservoir, "especially when coupled with a project to conserve water, and to improve and insure the supply available for the municipal water system." (See resolution No. 1560, enclosure 6.)<sup>1</sup>

63. The problem of water conservation has been included in the investigation of the various plans for the control of floods on the lower Ventura River by means of reservoirs. Reservoirs on the tributaries of the Ventura River would not provide adequate protection against floods on the lower river because only a small part of the run-off would be intercepted by such reservoirs. Since a reservoir at the Foster Park site, on the main stream at river mile 6, would provide considerable flood control and incidental water conservation, this site has been given full consideration. (See plans A, B, and C, pars. 47 to 51, and enclosure 4.)<sup>1</sup>

64. *Feasibility of multiple-purpose projects.*—Four reservoir sites were considered, three on tributaries of Ventura River and one on the main stream at Foster Park, river mile 6. Since the three storage sites located on the tributaries would provide only partial flood control and since their combined cost, including the cost of required channel improvement on the lower river, would be high, it is evident that the use of these storage sites for flood control combined with water conservation could not be justified.

65. A reservoir on the main stream at Foster Park for flood control and water conservation combined was also found to be too costly. (See plans A, B, and C, pars. 47 to 51, and enclosure 4.)<sup>1</sup>

66. In view of the foregoing, it is believed that a multiple-purpose project for flood control and water conservation combined cannot be justified in the Ventura River Basin at this time.

67. *Water rights.*—The water supply for the cities of Ventura and Ojai, and for the irrigated land in the Ventura River Basin, is obtained from surface streams and underground storage. There is a demand for additional water for both domestic and irrigation use, and local interests have considered various plans for an additional water supply. Water conservation entails full consideration of water rights. Levee construction or channel improvement on lower Ventura River and the construction of a flood channel within the city of Ojai, as recommended in this report, would not affect existing water rights.

68. *Miscellaneous factors.*—There are no problems of navigation and allied problems that may be coordinated with the plan of improvement for the lower Ventura River.

69. Pursuant to section 5 of the Rivers and Harbors Act of August 30, 1935, the district engineer reports that the flood-control improvements considered feasible will not affect appreciably the amount of silt and debris entering the ocean and will not affect the ocean beaches or any proposed harbor site at or in the vicinity of the Ventura River. It is

<sup>1</sup> Not printed.

therefore believed that an investigation by the Shore Protection Board is not required.

70. *Summary of all benefits.*—The totals of all benefits estimated to accrue from flood-control improvements recommended are as follows:

*Estimated average annual benefits from flood control on lower Ventura River*

Tangible benefits:	
Flood damage prevented.....	\$70,500
Increase in land value.....	2,800
Intangible benefits (not evaluated).....	
Total.....	73,300

*Estimated average annual benefits from flood control, Stewart Canyon, in the city of Ojai*

Tangible benefits:	
Flood damage prevented.....	\$15,000
Increase in land value.....	800
Intangible benefits (not evaluated).....	
Total.....	15,800

Details concerning the estimated benefits from recommended improvements and the improvements included in other plans are given in enclosure 3.<sup>1</sup>

#### JUSTIFICATION OF PROJECT AND ALLOCATION OF COSTS

71. *Economic and other justifications of project.*—Flood-control improvements on lower Ventura River, by means of a levee as recommended, will have annual charges estimated at \$55,000 and annual benefits estimated at \$73,300. The ratio of annual benefits to annual charges is 1.33. This substantial margin of economic justification is supplemented by large intangible benefits, due to prevention of a probable large loss of life in the overflow area.

72. In the city of Ojai the control of floods from Stewart Canyon, by means of the debris basin and a concrete channel proposed under the recommended plan, cannot be justified on the basis of tangible benefits alone. The annual charges for this improvement are \$32,300, and the annual benefits \$15,800. This gives an economic ratio of 0.49. However, in Ojai there is danger of a large loss of life from major floods, and it is therefore believed that such a plan of flood control is justified on the basis of intangible benefits alone.

73. *Allocation of costs, etc.*—If a project is adopted for flood control in the Ventura River Basin in accordance with the recommended plan, it is believed that local interests should meet the requirements of local cooperation outlined below. In connection with the proposed improvements on lower Ventura River, the city and county of Ventura should (1) provide, without cost to the United States, all lands, easements, and other forms of rights-of-way necessary for the construction of the flood-control works; (2) hold and save the United States free from all claims for damages arising from the construction and operation of the works; (3) assume the cost of the relocation of all public utilities required in the construction of the works; (4) maintain the completed works in a condition satisfactory to the Secretary of War; and (5) negotiate a definite mutual agreement concerning an equitable divi-

<sup>1</sup> Not printed.

sion or assignment of responsibility between the county and the city, and provide a mutually satisfactory organization to carry out the prescribed conditions of local cooperation. For the works in Ojai, the city of Ojai should (1) provide, without cost to the United States, all lands, easements, and other forms of rights-of-way necessary for the construction of the flood-control works; (2) hold and save the United States free from all claims for damages arising from the construction and operation of the works; (3) assume the cost of relocation of all the public utilities required in the construction of the works; (4) assume the costs of construction of all the street and highway bridges required in connection with the improvements; and (5) maintain the completed works in a condition satisfactory to the Secretary of War.

74. *Local cooperation.*—The Board of Supervisors of Ventura County and the Council of the city of San Buenaventura (Ventura) have submitted resolutions indicating their willingness, if a project is adopted for flood control on lower Ventura River, to meet the requirements of local cooperation. Likewise the Council of the City of Ojai has submitted a resolution indicating its willingness, if a project is adopted for flood control in the city of Ojai, to meet these requirements. Copies of the resolutions are submitted as enclosure 6.<sup>1</sup>

#### FLOOD CHANNEL DELINEATION

75. One of the basic features of flood-control design is the requirement that the flood-carrying capacity of the channel shall be adequate. On lower Ventura River, opposite the proposed levee improvement, the channel is to be cleared of trees, brush, and drift in connection with the construction of the improvement. Channel lines have been determined and are described in the discussion of plans. It is essential that the flood channel be kept free from encroachment in the future, in order to maintain the effectiveness of the flood-control works. Estimates of maintenance include cost of recurrent clearing and cleaning of the channel, and the requirements of such maintenance apply to both the channel and the levee. The project recommended for Ojai will require annual maintenance of the structures and cleaning of the debris basin by local interests.

#### DISCUSSION

76. Although during the past there has been flood damage throughout the Ventura River Basin, most of the losses have been concentrated in two areas. The greatest concentration of values and population menaced by floods is in the area along lower Ventura River, within and adjacent to the city of Ventura. The Ventura River during moderate floods overflows the greater part of the valley floor, and during great floods the floodwaters extend from the base of the hills on the right bank to the hills on the left bank, from Casitas Narrows (river mile 6) to the ocean. Most of the development along the lower river is concentrated in this area. The river is subject to rapid increase in volume of flow, and the relatively steep gradient of 37 feet per mile in this reach results in high-flood velocities accompanied by considerable debris movement.

<sup>1</sup> Not printed.

77. The recommended plan for flood control, which provides a single levee extending from the ocean along the left bank of Ventura River to a point about 2.6 miles upstream, gives protection to the city of Ventura and the suburban area adjacent and to the north of the city. Of all plans considered, this improvement shows the least cost and the highest benefit-cost ratio, 1.33, and realizes most of the intangible benefits which could accrue from improvements under any of the plans considered. The six alternative plans considered include provision for flood control by combinations of dams and channels, channel improvements alone, and levee construction. Plan A provides partial protection to that part of the Ventura Avenue oil field lying in the river valley and makes possible the reclamation of overflow lands along the right bank of the present channel near its mouth. Its high cost and low economic ratio, 0.34, led to the rejection of this plan. Plan B provides the same protection to the oil field and the valley immediately below Foster Park as in plan A, but does not permit of the reclamation of overflow lands on the right bank of the present channel. Although the total cost under this plan is considerably less than that under plan A, the economic ratio is only 0.43. Plan C provides full protection against the design flood to the entire valley below Casitas Narrows (Foster Park). It is the most expensive plan considered and has an economic ratio of only 0.27. Plans D and E consist of channel improvements which give full protection to the valley below the oil fields and the valley below Casitas Narrows, respectively. Plan D has an economic ratio of 0.46 and at relatively low cost provides for the reclamation of undeveloped lands and also affords slightly more benefits from flood damage prevented than the recommended plan. Of any plan considered, plan E has the lowest economic ratio, 0.19. Plan F includes protection to United States Highway 101 and the Southern Pacific Coast Line Railroad, not afforded by the improvement under the recommended plan. In comparison with the economic ratio of 1.33 for the recommended plan, the economic ratio, 1.15, of plan F indicates that this additional protection could be provided only by the sacrifice of economic justification. The existing bridges can be replaced at any time without reducing the effectiveness of the levee or endangering the levee in time of flood. The rebuilding of these bridges would not materially reduce the cost of the levee, since the principal purpose in rebuilding them would be to make them safe against all floods.

78. The first three alternative plans provide some water conservation which has been evaluated and included in the calculation of their economic ratios. Local interests are especially interested in a multiple-purpose project, but after investigations revealed that such a project is infeasible, their support of a flood control project alone has been assured. The investigations have revealed that flood control and water conservation can be more economically provided separately than by a combined project.

79. Local interests are considering the location of a major highway along the lower river below the oil field; otherwise Ventura Avenue must be widened at considerable expense to carry the growing volume of traffic. The location and cross section of the channel in plan D are such that a highway could be constructed along its left bank at small additional cost for its right-of-way and subgrade. However, the great difference between the cost of plan D and the recommended

plan, and the more favorable economic ratio of the latter, have eliminated plan D from favorable consideration.

80. Throughout the other parts of the overflow area of the basin, flood control is not justified at this time except within the city of Ojai. Here in the center of the city is an overflow area in which a considerable number of people live and the property values are relatively high. Floods that cause damage in Ojai come from a steep mountain canyon and are characterized by high rates of run-off and large volumes of debris movement. The construction of a debris basin is essential to the control of the canyon discharge, and the channel recommended furnishes the shortest practical route of disposal to a point in a natural channel of sufficient size to carry the largest flood. The ratio of economic justification of this plan is 0.49, but the large intangible benefits, due to prevention of loss of life, justify the improvement. Local interests have stated their intention to cooperate in the construction of these works and the City Council of Ojai has passed a resolution to that effect.

81. Desires of local interests for flood control in the agricultural area east of the city of Ojai could not be met because of the high cost of such works and the low ratio of benefits to cost, amounting to 0.15. Due to steep slopes, large amount of debris (boulders, gravel, and sand), and volume of water to be controlled, there is no feasible method of providing partial flood control for those areas where values are highest.

#### CONCLUSIONS

82. It is concluded that—

(a) There is a serious flood menace to life and property on Ventura River below the Ventura Avenue oil field and in the city of Ojai just below Stewart Canyon.

(b) Adequate protection can be provided on lower Ventura River by a levee on the left bank extending from high ground below the Ventura Avenue oil field to the mouth of the river; and adequate protection can be provided for the city of Ojai by a debris basin at the mouth of Stewart Canyon and a concrete channel through the city.

(c) The total cost of the proposed improvement for the lower Ventura River would be \$1,152,000, and for the city of Ojai, \$587,000.

(d) The proposed improvement for lower Ventura River, having a ratio of benefits to cost of 1.33, is economically justified; and the proposed improvement for the city of Ojai, having a ratio of benefits to cost of 0.49, also is justified, but by reason of the large intangible benefits.

#### RECOMMENDATIONS

83. The district engineer recommends—

(a) That a project be approved for the construction of a levee for flood control on lower Ventura River at an estimated cost of \$1,084,000 for construction of flood-control works, \$6,000 for relocation of utilities, \$62,000 for rights-of-way, and an estimated maintenance cost of \$5,300 per annum; and also the construction of a debris basin and channel in the city of Ojai at an estimated cost of \$520,000 for construction of flood-control works, \$4,000 for relocation of utilities, \$27,000 for bridges or culverts, \$36,000 for rights-of-way, and an estimated maintenance cost of \$6,700 per annum.

(b) That local interests be required to cooperate as follows: (1) Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the flood-control works; (2) hold and save the United States free from all claims for damages arising from the construction and operation of the works; (3) assume the cost of the relocation of all public utilities required in the construction of the works; (4) assume the cost of construction of all the street and highway bridges required in connection with the improvements; and (5) maintain the completed works in a condition satisfactory to the Secretary of War.

(c) That the United States pay all other costs and perform all other work entailed in the construction of the recommended improvements.

(d) That Federal funds sufficient to complete the improvements be made available in one allotment of \$1,604,000.

EDWIN C. KELTON,  
*Lieutenant Colonel, Corps of Engineers,*  
*District Engineer.*

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[First endorsement]

OFFICE, DIVISION ENGINEER,  
SOUTH PACIFIC DIVISION,  
*San Francisco, November 28, 1940.*

To the Chief of Engineers, United States Army:

1. The district engineer finds that there has been flood damage throughout the Ventura River Basin, but that most of the losses have been concentrated in two areas, the lower Ventura River, in and near the city of Ventura, and in the city of Ojai, which is below Stewart Canyon. He finds that flood control is not justified in the other parts of the overflow area of the basin.

2. He finds that there is a flood menace to life and property on lower Ventura River and he concludes that suitable protection to Ventura and the limited adjacent area can be provided by a levee on the left bank of the river, extending for a distance of about 2.6 miles. He estimates the total cost of the improvement at \$1,152,000; the annual carrying charges at \$55,000; the total annual benefits at \$73,300; and the ratio of annual benefits to annual charges at 1.33. The estimate of annual benefits includes prevention of direct and indirect flood damages at \$70,500 and the annual benefits from increased land values at \$2,800. He finds that the substantial margin of economic justification is supplemented by intangible benefits due to prevention of a possible large loss of life.

3. The district engineer also finds that in the greater part of the city of Ojai there is an overflow area in which many people live and where property values are relatively high; that, floods causing damage in Ojai come from a steep mountain canyon and are characterized by high rates of run-off and large volumes of debris movement; that debris control also is essential to the control of Stewart Canyon discharge. He concludes that adequate protection to the city of Ojai can be provided by the construction of a debris basin at the mouth of Stewart Canyon, and a rectangular concrete channel extending from the debris basin through the city to a natural channel of adequate

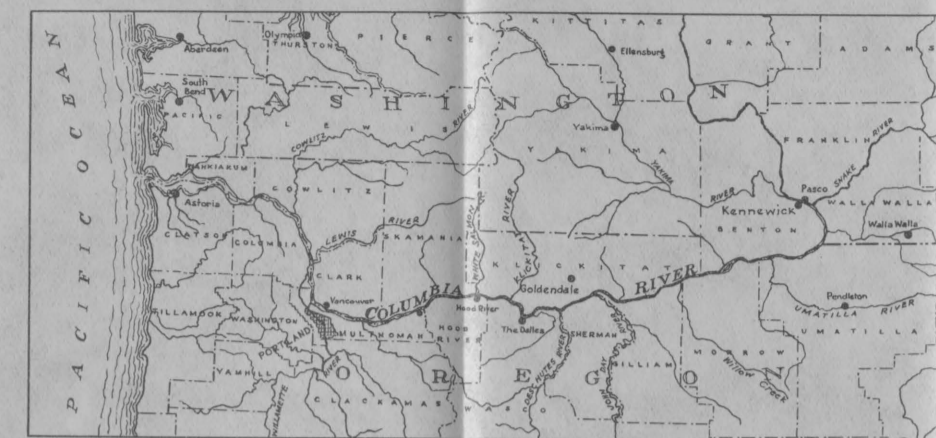
capacity. He estimates the total cost of the improvement at \$587,000; the annual carrying charges at \$32,300; the estimated average annual preventable damage at \$15,000; and estimated additional annual benefits from increased land value at \$800; and the ratio of tangible benefits to cost at 0.49. However, he points out that in Ojai there is danger of a large loss of life from major floods and it is his opinion that the plan of improvement is justified on the basis of intangible benefits alone.

4. The division engineer believes that the estimates of tangible benefits given in the report of the district engineer are reasonable and can be expected to accrue if the proposed improvements are constructed. It is his opinion that the intangible benefits are significant, particularly in the city of Ojai, and in this case are of themselves sufficient to justify construction of the plan of improvement as recommended by the district engineer. The division engineer concurs in the conclusions and recommendations of the district engineer.

WARREN T. HANNUM,  
*Colonel, Corps of Engineers,*  
*Division Engineer.*

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VICINITY MAP

Scale in Miles

4 MILES TO MOUTH OF SNAKE RIVER

NOTE:  
Soundings are referred to Low Water and are expressed in feet and tenths.  
7 ft. depth contour shown thus: ———  
Distance in miles from CELILO shown: (12)

# COLUMBIA RIVER KENNEWICK, WASHINGTON PLAN OF IMPROVEMENT

SCALE 1:6400  
SCALE IN FEET

U.S. ENGINEER OFFICE, BONNEVILLE, OREGON.

SUBMITTED: <i>Stanley E. J. J. J.</i>	APPROVED: <i>H. F. J.</i>
RECOMMENDED: <i>Allen A. Darr</i>	ENGINEER
SURVEYED BY: <i>J. M. B.</i>	DRAWN BY: <i>J. M. B.</i>
TRACED BY: <i>J. M. B.</i>	CHECKED BY: <i>J. M. B.</i>

TRANSMITTED WITH REPORT TO Division Engineer  
DATED: Jan. 22, 1941  
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